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AUTHOR Richards, David R.
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ABSTRACT

This study explores a relatively new area of computer research, i.e., utilization of computer-generated feedback based upon the knowledge gained in both written and computer-based instruction. One hundred and twenty-six freshmen and sophomore college students from a variety of academic majors volunteered for this study. The instructional materials included a 2,000 word script which described the parts and functions of the human heart. A self-paced computer program allowed the students to look at a series of 38 instructional frames of the heart, with associated graphics, and provided feedback to required student responses. Three major instructional treatment groups were established: simple, covert, and overt feedback. Four posttests were administered (drawing, identification, terminology, and comprehension tests), and a one-factor ANOVA was used to analyze scores for each of the four tests. The various types of feedback had different effects on the objectives measured by the posttests and also had a significant effect on the drawing test, which evaluated the student's ability to construct and reproduce items in their appropriate context. These results emphasize the fact that non-drill lessons do not automatically ensure increased learning of the content material; that all methods of computer-generated feedback are not equally effective in facilitating student achievement of different educational objectives; and that there is a need for further research on new methods to make computer-generated feedback more effective for the learner. (29 references) (CGD)

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A Comparison of Three Computer-Generated Feedback Strategies

David R. Richards

Penn State University
Hazleton Campus
Highacres
Hazleton, PA 18201

One of the advantages in utilizing computers to facilitate instruction is the ability to provide the student with immediate feedback to convey the correctness or incorrectness of his or her response. If computers are to be used as primary delivery systems in educational and training applications, additional research is necessary to determine which types of feedback are important for student achievement of different educational objectives.

There are numerous kinds of feedback. Feedback cannot be easily defined primarily because a number of theoretical positions are embedded in the concept today (Langer, 1983). Results indicate that all feedback strategies are not equally effective in facilitating student achievement of different educational objectives (Dwyer & Arnold, 1976). However, according to Langer (1983), feedback is considered a critical instructional component by most instructional systems analysts and psychologists.

Feedback can range from a simple knowledge of correct response such as "yes, that's right" or "no, that's wrong" (Travers, Van Wagen, Haygood, & McCormick, 1964) to an elaborate computer-based mechanism that continuously shows students what progress they have made toward mastery of an objective by providing meaningful advice and the appropriate stimuli necessary to obtain it (Tennyson & Buttrey, 1980). Kulhavy (1977) suggests that feedback could be treated as a unitary variable ranging along a continuum from a simple "Yes - No" to the presentation of substantial corrective or remedial information that may extend the response content, or add additional information to it.

Several research studies indicate that the most effective form of feedback is corrective feedback as opposed to positive feedback. Feedback has its greatest effect on high confidence errors (Kulhavy, Yekovich, & Dyer, 1976). Guthrie (1971) found that feedback facilitated learning when it followed incorrect responses and had no effect on learning following correct responses.

Gagne, Wagner, and Rojas (1981) consider that feedback is absolutely essential in designing computer assisted instruction. Tennyson and Buttrey (1980, p. 175) contended, "A learner-controlled condition can be a valuable instructional management system, especially for computer based instruction, if students receive sufficient information about their learning development."

The effectiveness of covert vs. overt learning strategies has produced somewhat mixed results in the literature. This is partially due to the type of learning being investigated and the methods used to produce covert or overt rehearsal. Overt learning strategies engage the learner in some form of outward or physical activity to aid in the encoding of information in long-term memory. Overt rehearsal, by requiring the learner to generate knowledge and/or produce and answer, makes the learner aware of limitations in his understanding (Bransford, 1979). Overt rehearsal, therefore, has the potential to be an effective learning strategy which facilitates retention. Dwyer (1984) discovered that a form of overt rehearsal in which students shaded portions of the human heart resulted in an effective rehearsal strategy to facilitate learning.

However, in non-drill computer lessons requiring a student to make an overt response by typing an answer immediately following feedback, the student learns to type the correct answer without attending to the question paired with the answer (Siegel & Misselt, 1984).

Covert rehearsal deals with internalizing or mentally processing information. Researchers (Bobrow & Bower, 1969; Anderson, Goldberg, and Hidde, 1971; Bransford, 1979; Dwyer, 1984) generally found the covert activity of reading correct statements does not provide for a level of processing activity to be significant. However, the ineffectiveness of the covert activity of reading correct statements does not conclude that all covert methods are ineffective. One of the major problems involved in conducting research on covert rehearsal is determining the extent to which the learner is actually performing the covert rehearsal task.

The utilization of feedback in computer-based instruction is a relatively new area which requires additional research to further enhance the knowledge base in this area. This study attempts to explore this area of computer generated feedback based upon the knowledge gained in both written and computer-based instruction.

METHODS

Subjects

One hundred twenty-six freshman and sophomore college students participated in this study. Volunteer participants represented a variety of academic majors.

Instructional Materials

The instructional materials used in this study consisted of the parts and functions of the human heart developed by Dwyer (1965). The materials included a 2,000 word script which described the parts of the heart and their respective roles in the diastolic and systolic phases and four posttests (drawing, identification, terminology, and comprehension).

Programed instructional booklets developed by Parkhurst (1974) were used as a guide for organizing the heart script into instructional frames. These frames, including the associated graphics, became the basis for the development of an instructional computer program by the author in Pascal for IBM and compatible computers.

The program was self-paced allowing the student to look at a frame until the space bar was pressed. There were 38 instructional frames, all but the first had associated questions requiring a student response and providing feedback.

Instructional Treatments

There were three major instructional treatment groups - simple feedback, covert feedback, and overt feedback. Identical instructional frames consisting of text and a labeled graphic of the heart were presented to each group. Following each instructional frame was a question frame. The treatments differed in the associated feedback frames following the student response to the question.

For example, one frame had a short paragraph which discussed the concept that the lower portion of the heart is called the apex and is the part you feel beating. The heart graphic had a label box with the term APEX inside with a line drawn to the lower portion of the heart.

The associated question presented after the instruction was: The portion of the heart that you feel beating is called the _____. The student was then required to type a response.

Simple feedback consisted of the statement "Your answer is correct." or "Your answer is NOT correct." followed by the correct answer and a computer graphic of the heart with the correct answer displayed as a label. Covert feedback was the same as the first treatment except the graphic of the heart had blank label boxes with time delayed labels allowing the student to make a covert response by visualizing the correct label in his or her mind before it appeared. During overt feedback, students were required to make an overt response by entering the correct answer to the question a second time. The computer program would only accept the correct answer and displayed it letter by letter in the proper position on the graphic as it was typed.

Dependent Measures

Dependent measures were the scores on each of the four posttests. The objective of the drawing test was to evaluate the student ability to construct and/or reproduce items in their appropriate context. The identification test evaluated student ability to identify parts or positions of an object. It consisted of 20 multiple choice items. The terminology test also consisted of 20 multiple choice items and was designed to measure the student's knowledge of specific facts, terms, and definitions. In the 20-item comprehension test, the student was given the location of certain parts of the heart at a particular moment of its functioning, then ask to locate the position of other specified parts of the heart at the same point of time.

Procedure

The 126 participants were randomly assigned to one of the three treatment groups with a group size of 42. Each participant was individually given brief instruction on the physical operation of the computer and the instructional program. Participants then proceeded through the instructional unit at their own pace. The tests were administered to the students as they completed the unit. Subjects completed and returned the drawing test before receiving the identification, terminology, and comprehension tests.

Data Analysis

A one-factor ANOVA was used to analyze scores for each of the 4 tests. A total composite test score consisting of the accumulated scores of the identification, terminology, and comprehension tests was also analyzed.

For all statistical analyses and follow-up tests, alpha was set at the .05 level. If a significant F-ratio was found for the feedback method, the means were tested using the Tukey Wholly Significant Difference Test.

RESULTS

Table 1 contains the means and standard deviations for three feedback groups for each of the tests. Significant differences were found for 3 of the 4 tests and for the total test scores. No significant differences were found for the identification test.

Significant differences were found for the terminology test with $F(2,123) = 3.64$, $p < .05$. The comprehension test scores were significant with $F(2,123) = 4.81$, $p = .01$. The composite total test scores were also significantly different with $F(2,123) = 4.53$, $p = .01$. The greatest significant differences were found for the drawing test with $F(2,123) = 13.43$, $p < .001$.

The follow-up tests indicated the covert feedback scores were significantly higher in every test. The simple and overt groups were found to produce equivalent results in the terminology and comprehension tests and for the total test scores. However, the covert and overt group scores were similar for the drawing test and better than the simple feedback group. In summary, the scores were generally the greatest for the covert method and the least for the simple feedback method with the overt method equivalent to the simple method in most cases.

TABLE 1
Mean Scores and Standard Deviations on Posttests

TEST		FEEDBACK GROUP			Totals
		Simple	Covert	Overt	
Identification (N = 42)	Mean	14.7	16.1	14.9	15.2
	SD	3.3	3.0	3.5	3.3
Terminology (N = 42)	Mean	11.6	13.6	11.5	12.2
	SD	4.2	4.0	3.9	4.0
Comprehension (N = 42)	Mean	11.7	14.3	12.3	12.8
	SD	4.2	3.7	3.9	3.9
Total (I+T+C) (N = 42)	Mean	38.0	44.0	38.8	40.3
	SD	10.5	9.2	10.0	9.9
Drawing (N = 42)	Mean	12.6	17.0	15.5	15.0
	SD	4.5	3.4	3.8	3.9

DISCUSSION

The various types of feedback had different effects on the objectives measured by the posttests ranging from the identification test which required a minimal level of learning factual information to the comprehension test that required the students to have a thorough understanding of the heart, its parts, its internal functions, and the simultaneous processes occurring during its phases. The various feedback strategies also had a significant effect on the drawing test which evaluated the student's ability to construct and reproduce items in their appropriate context.

The covert strategy in which subjects viewed unlabeled boxes and attempted to mentally fill in the labels before the actual labels appeared after a time delay, proved to be the most significant method in this study. Past researchers (Bobrow and Bower, 1969; Anderson, Goldberg, and Hidde, 1971; Bransford, 1979; Dwyer, 1984) generally found that covert rehearsal strategies do not provide a level of processing activity to be significant. Their failure to find significant effects may have resulted from the level of covert activity being utilized such as reading statements.

The covert activity in this study differed because the computer focused the subjects attention on the screen by using an unlabeled box as a cueing technique and at the same time challenged the student to visualize the correct answer before it appeared. This additional motivational aspect apparently produced a level of internal processing allowing for significant encoding of information into long-term memory. Another explanation for the success of the covert strategy and the contradiction to previous research was that it was incorrectly named covert when in fact it was an overt strategy. It was highly structured and engaged the subjects in an intense form of mental interaction. In fact, the investigator observed outward physical signs when subjects recalled the correct label in the blank box or failed to mentally fill in the label before the time expired and the label appeared. A truly covert activity such as reading summary statements would not elicit a physical response. The previous research involving covert rehearsal was based on a lesser level of mental activity. If the covert method is renamed as another overt strategy, its strengths would be supported by prior studies which actively engaged the learner in a rehearsal activity.

The overt strategy was less effective than the covert strategy when compared to the simple feedback method. The overt strategy required the student to correctly type the answer to the frame question a second time while it was displayed in the appropriate position on the graphic of the heart. Although overt methods have generally been more effective than covert methods is previous research. The result of this particular strategy supports Siegel and Misselt (1984) who stated in non-drill computer lessons requiring a student to make an overt response by typing an answer immediately following feedback, the student learns to type the correct answer without attending to the question paired with the answer. Typing is a motor skill that does not always require concentration on the item being typed.

The overt strategy was superior to simple feedback but not significantly different from the covert strategy in the drawing test. This may have resulted because subjects were using visual images of the screen to reproduce the heart and locate its components. This activity was independent of utilizing feedback to reinforce or correct answers to the question that were needed to do well in the other tests. Both covert and overt methods were comprised of more elaborate feedback screens to enhance this internal visual model. This could indicate a dual-coding (Paivio, 1971) in which the visual information was more effectively coded than the corresponding verbal information associated with the frame question.

These results emphasize the importance of this type of research for the instructional designer who might otherwise conclude the repetitive typing of correct answers during non-drill lessons would automatically insure increased learning of the content material. Another major finding of this study emphasizes that all methods of computer generated feedback are not equally effective in facilitating student achievement of different educational objectives. However, if properly designed, computer-generated feedback has the potential of being very effective. In practical terms, the instructional designer could gain from the findings of this study and design computer-based instructional software incorporating the idea of time delayed labels. This method could be also applied to primary instruction.

A final point of discussion deals with whether or not methods used in this study were actually feedback. Using a strict definition of feedback as information on the correctness of a response, they were not. However, Kulhavy (1977) suggested that feedback could be treated as a variable ranging along a continuum from a simple "Yes - No" to the presentation of substantial corrective or remedial information that may extend the response content, or add additional information to it. This study used more elaborate methods that prompted students to attend to the feedback. There is a need for further research involving new methods to make computer-generated feedback more effective for the learner.

REFERENCES

- Anderson, R. C., Goldberg, S. R., & Hidde, J. L. (1971). Meaningful processing of sentences. Journal of Educational Psychology, 62, 395-399.
- Bardwell, R. (1981). Feedback: How does it function. Journal of Experimental Education, 50, 148-156.
- Bobrow, S. A., & G. H. Bower. (1969). Comprehension and recall of sentences. Journal of Experimental Psychology, 80, 455-461.
- Bransford, J. D. (1979). Human Cognition: Learning, Understanding, and Remembering. Belmont, California: Wadsworth Publishing Company.
- Carter, J. (1984). Instructional learner feedback: A literature review with implications for software development. The Computing Teacher, 12(2), 53-55.
- Cipani, E. (1984). Using time delay fading in the design of CAI. The Computing Teacher, 12(6), 12-13.
- Cohen, V. B. (1985). A Reexamination of feedback in computer-based instruction: Implications for instructional design. Educational Technology, 33-37.
- Dwyer, C. A. (1985). The effect of varied rehearsal strategies in facilitating achievement of different educational objectives as measured by verbal and visual testing modes. Unpublished doctoral dissertation, The Pennsylvania State University.
- Dwyer, F. M. (1965). An experimental evaluation of the relative effectiveness of selected visual illustrations in teaching science concepts to college freshman. Unpublished doctoral dissertation, The Pennsylvania State University.
- Dwyer, F. M. (1978). Strategies for Improving Visual Learning. State College, Pennsylvania: Learning Services.
- Dwyer, F. M., & Arnold, T. A. (1976). The instructional effect of verbal/visual feedback in visualized instruction. Journal of Psychology, 94, 39-41.
- Gagne, R. M., Wagner, W. & Rojas, A. (1981). Planning and authoring computer assisted instructional lessons. Educational Technology, 21, 17-26.
- Gall, M. D. (1970). The use of questions in teaching. Review of Educational Research, 40(5), 707-721.
- Guthrie, J. T. (1971). Feedback and sentence learning. Journal of Verbal Learning and Verbal Behavior, 10, 23-28.

- Hodes, C. L. (1984). Relative effectiveness of corrective and noncorrective feedback in computer assisted instruction on learning and achievement. Journal of Educational Technology Systems, 13(4), 249-254.
- Kulhavy, R. W. (1977). Feedback in written instruction. Review of Educational Research, 47(1), 211-232.
- Kulhavy, R., Yekovich F., & Dyer, J. (1976). Feedback and response confidence. Journal of Educational Psychology, 68(5), 522-528.
- Kulhavy, R., Yekovich F., & Dyer, J. (1979). Feedback and content review in programmed instruction. Contemporary Educational Psychology, 4, 91-98.
- Langer, P. C. (1983). Instruction and the feedback dilemma. ERIC, ED 230 547, April.
- Paivio, A. (1971). Imagery and Verbal Process, New York: Holt, Rinehart and Winston.
- Parkhurst, P. E. (1974). Assessing the effectiveness of self-paced visualized instruction: A multifactor analysis on five different educational tasks. Unpublished doctoral dissertation, The Pennsylvania State University.
- Richards, D. R. (1987). An experimental assessment of the relative effectiveness of varied types of computer-generated feedback strategies in facilitating achievement of different educational objectives as measured by verbal and visual tests. Unpublished doctoral dissertation, The Pennsylvania State University.
- Roper, A. L. (1977). Feedback in computer-assisted instruction. Programmed Learning and Educational Technology, 14, 43-49.
- Sassenrath, J. M. (1977). Theory and results on feedback and retention. Journal of Educational Psychology, 67, 894-899.
- Siegel, M. A., & Misselt, A. L. (1984). Adaptive feedback and review paradigm for computer-based drills. Journal of Educational Psychology, 76(2), 310-317.
- Stevens, M. J. (1985). A brief overview and evaluation of covert positive reinforcement. Psychology, A Quarterly Journal of Human Behavior, 22, 71-79.
- Tennyson, R. D., & Buttrely T. (1980). Advisement and management strategies as design variables in computer-assisted instruction. Educational Communication and Technology: A Journal of Theory, Research & Development, 28(3), 169-176.

Travers, R. M. W., VanWagen, R. K., Haygood, D. H., & McCormick, M. (1964). Learning as a consequence of the learner's task involvement under different conditions of feedback. Journal of Educational Psychology, 55, 167-173.

Wager, W. & Wager, S. (1985). Presenting questions, processing responses, and providing feedback in CAI. Journal of Instructional Development, 8(4), 2-8.